Name Key

Acids and Bases Practice Test

1. The hydrogen sulfate or bisulfate ion HSO_4^- can act as either an acid or a base in water solution. In which of the following equations does HSO_4^- fit the definition of an acid?
   a) $HSO_4^- + H_2O \rightarrow H_2SO_4 + OH^-$
   b) $HSO_4^- + H_3O^+ \rightarrow SO_3 + 2H_2O$
   c) $HSO_4^- + OH^- \rightarrow H_2SO_4 + O^{2-}$
   d) $HSO_4^- + H_2O \rightarrow SO_4^{2-} + H_3O^+$
   e) none of these

2. Which of the following is a conjugate acid/base pair?
   a) HCl/OCl^-
   b) H_2SO_4/SO_4^{2-}
   c) NH_4^+/NH_3 off by 1 H^+
   d) H_3O^+/OH^-
   e) none of these

3. The dihydrogenphosphate ion, $H_2PO_4^-$, has both a conjugate acid and a conjugate base. These are, respectively:
   a) H_3PO_4, PO_4^{3-}
   b) H_3PO_4, HPO_4^{2-} conj acid = 1 extra H^+
   c) $H_2PO_4^-$, HPO_4^{2-} conj base = 1 less H^+
   d) HPO_4^{2-}, PO_4^{3-}
   e) HPO_4^{2-}, H_3PO_4

4. Given the following acids and K_a values:

$HClO_4$	HOAc	HCN	HF
1×10^7	1.76×10^{-5}	4.93×10^{-10}	3.53×10^{-4}

   which shows the conjugate bases listed by increasing strength?
   a) CN^-, F^-, OAc^-, ClO_4^-
   b) CN^-, OAc^-, F^-, ClO_4^-
   c) CN^-, ClO_4^-, F^-, OAc^-
   d) ClO_4^-, OAc^-, CN^-, F^-
   e) ClO_4^-, F^-, OAc^-, CN^-

conj of strong acid — conjugate of the weakest acid

5. Which of the following is the equilibrium constant expression for the dissociation of the weak acid HOCl?

a) $K = \frac{[H^+][OCl^-]}{[HOCl]}$ b) $K = [H^+][OCl^-]$

c) $K = \frac{[HOCl]}{[H^+][OCl^-]}$ d) $K = \frac{[H^+][O^{2-}][Cl^-]}{[HOCl]}$

e) none of these

6. What is the equilibrium constant for the following reaction?

$$N_3^- + H_3O^+ \rightleftharpoons HN_3 + H_2O$$

The K_a value for $HN_3 = 1.9 \times 10^{-5}$.

a) 5.3×10^{-10}

b) 1.9×10^{-9}

c) 1.9×10^{-5}

d) 5.3×10^{4}

e) 1.9×10^{9}

for reverse reaction

$K_{rev} = \frac{1}{K_{forward}}$

7. Calculate the pH of a 0.050 M strong acid solution.

a) -1.30

b) 1.30

c) 12.70

d) 15.30

e) none of these

$-\log(.050) = 1.30$

8. Calculate the $[H^+]$ in a solution that has a pH of 11.70.

a) 2.3 M

b) 11.7 M

c) 5.0×10^{-3} M

d) 2.0×10^{-12} M

e) none of these

$10^{-11.70} = 2.0 \times 10^{-12}$ M

9. Solid calcium hydroxide is dissolved in water until the pH of the solution is 10.94. The hydroxide ion concentration $[OH^-]$ of the solution is:

a) 1.1×10^{-11} M

b) 3.06 M

c) 8.7×10^{-4} M

d) 1.0×10^{-14} M

e) none of these

$pOH = 14 - 10.94 = 3.06$

$[OH^-] = 10^{-3.06} = 8.7 \times 10^{-4}$ M

10. For weak acid, HX, $K_a = 1.0 \times 10^{-3}$. Calculate the pH of a 0.10 M solution of HX.

a) 2.00
b) 3.50
c) 3.00
d) 2.50
e) none of these

$$1.0\times10^{-3} = \frac{x^2}{.1-x}$$

$$1\times10^{-4} - 1\times10^{-3}x - x^2 = 0$$

$$x = .00951$$

$$pH = 2.02$$

	HX	H^+	X^-
I	.10	0	0
C	-x	x	x
E	.1-x	x	x

11. Acetic acid ($HC_2H_3O_2$) is a weak acid ($K_a = 1.8 \times 10^{-5}$). Calculate the pH of a 17.6 M $HC_2H_3O_2$ solution.

a) 4.31
b) 6.40
c) 1.75
d) 0.97
e) 7.40

$$1.8\times10^{-5} = \frac{x^2}{17.6}$$

$$x = .0178$$

$$-\log(.0178) = 1.75$$

12. How many moles of benzoic acid, a monoprotic acid with $K_a = 6.4 \times 10^{-5}$, must be dissolved in 500. mL of H_2O to produce a solution with pH = 2.50?

a) 1.6×10^{-1}
b) 2.0×10^{-2}
c) 7.8×10^{-2}
d) 0.50
e) none of these

$$[H^+] = 10^{-2.5} = 3.16\times10^{-3}$$

$$K_a = 6.4\times10^{-5} = \frac{(3.16\times10^{-3})^2}{[HA]}$$

$$[HA] = .1563\ M$$

$$\frac{x}{.500\ L} = .1563M \qquad x = 0.078\ mol$$

13. The pH of a 0.100 M solution of an aqueous weak acid (HA) is 3.20. The K_a for the weak acid is:

a) 6.3×10^{-4}
b) 7.2×10^{-5}
c) 4.0×10^{-6}
d) 3.2
e) none of these

$$[H^+] = 10^{-3.2} = 6.31\times10^{-4}M$$

$$K_a = \frac{(6.31\times10^{-4})^2}{(.1-6.31\times10^{-4})} = 4.0\times10^{-6}$$

14. A solution of 8.0 M formic acid (HCOOH) is 0.47% ionized. What is the K_a of formic acid?

a) 3.4×10^{-8}
b) 1.8×10^{-4}
c) 6.9×10^{-6}
d) 3.8×10^{-2}
e) need more data

	HCOOH	H^+	$COOH^-$
I	8.0	0	0
C	-.0376	+x	+x
E	7.9624	.0376	.0376

$$K_a = \frac{(.0376)^2}{7.9624} = 1.8 \times 10^{-4}$$

15. As water is heated, its pH decreases. This means that
a) the water is no longer neutral.
b) the K_w value is decreasing.
c) the water has a lower $[OH^-]$ than cooler water.
d) the dissociation of water is an endothermic process.
e) none of these.

16. If you know K_b for ammonia, NH_3, you can calculate the equilibrium constant, K_a, for the following reaction:

$$NH_4^+ \rightleftharpoons NH_3 + H^+$$

by the equation:
a) $K_a = K_w K_b$
b) $K_a = K_w / K_b$
c) $K_a = 1/K_b$
d) $K_a = K_b / K_w$

17. Calculate the pH of a 0.02 M solution of KOH.
a) 1.7
b) 2.0
c) 12.0
d) 12.3
e) none of these

$$pOH = -\log(.02) = 1.7$$
$$14 - 1.7 = 12.3$$

18. Calculate the pH of a 0.10 M solution of pyridine (C_5H_5N; $K_b = 1.7 \times 10^{-9}$):
a) 8.15
b) 5.88
c) 9.12
d) 11.24
e) none of these

$$1.7 \times 10^{-9} = \frac{x^2}{.10}$$
$$x = [OH^-] = 1.3 \times 10^{-5}$$
$$pOH = 4.88 \qquad 14 - 4.88 = 9.12$$

19. Calculate the pH of a 0.050 M solution of H_2SO_4 (K_{a1} = very large; $K_{a2} = 1.2 \times 10^{-2}$).

$H_2SO_4 \longrightarrow H^+ + HSO_4^-$

.05 .05

$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$

$[H^+] = .050 + .019 = .069$

$.012 = \frac{x^2}{(.05-x)}$

$pH = -\log(.069)$

$pH = 1.16$

$.0006 - .012x - x^2 = 0$

$x = .019$

20. The pH of a 1.0 M sodium acetate solution is:

a) 7.0
b) greater than 7.0
c) less than 7.0
d) not enough information is given
e) none of these (a-d)

↳ conjugate of a weak acid

21. What is the pH of a 0.45 M KCl solution?

a) 10.50
b) 7.00
c) 9.20
d) 1.40
e) 4.50

↳ neutral

KOH & HCl are both strong

22. Calculate the pH of a 0.30 M solution of NH_4Cl. (K_b for $NH_3 = 1.8 \times 10^{-5}$)

a) 3.33
b) 4.89
c) 9.11
d) 7.00
e) 11.67

$NH_4^+ \rightleftharpoons NH_3 + H^+$

$K_a = \frac{10^{-14}}{1.8 \times 10^{-5}}$

$K_a = 5.56 \times 10^{-10}$

$5.56 \times 10^{-10} = \frac{x^2}{.30}$

$x = 1.3 \times 10^{-5}$

$pH = -\log(1.3 \times 10^{-5}) = 4.89$